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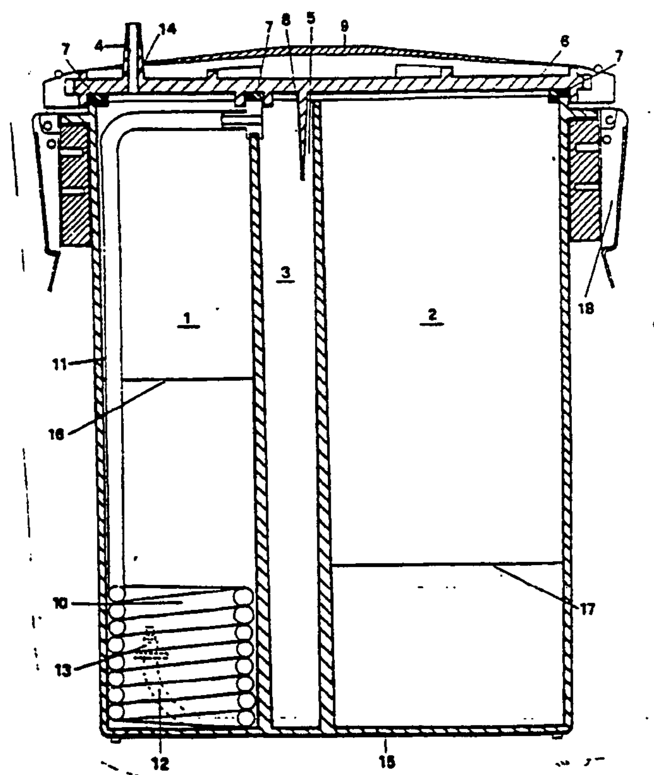
(54) Title: PROCESS FOR THE PRODUCTION OF OXYGEN BY A PORTABLE APPARATUS, PARTICULARLY FOR HUMAN RESPIRATION AND APPARATUS TO CARRY OUT THE PROCESS

(57) Abstract

The process for the production of oxygen through a portable apparatus foresees that a mixture of sodium percarbonate and sodium perborate in presence of a suitable catalyst and water is made to react inside a tight vessel (1) according to the reaction $2Na_2CO_3 . 3H_2O_2 + NaBO_2.H_2O_2 \longrightarrow 2Na_2CO_3 + NaBO_2 + 4H_2O + 2O_2$ and thus the gaseous oxygen and satured steam flow obtained from such a reaction is made pass through an heat exchanger (2) which cools and dehumidifies it.



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"PROCESS FOR THE PRODUCTION OF OXYGEN BY A PORTABLE APPARATUS, PARTICULARLY FOR HUMAN RESPIRATION AND APPARATUS TO CARRY OUT THE PROCESS"

The present invention relates to a process for the production of oxygen by a portable apparatus, particularly for human respiration and an apparatus to carry out the process.

It is known that it is possible to obtain oxygen for human respiration from the decomposition of sodium percarbonate ($2Na_2CO_3.3H_2O_2$) according to the following reaction

$$2Na_2CO_3.3H_2O_2 \longrightarrow 2Na_2CO_3 + 1,5O_2 + 3H_2O$$

Such a decomposition is obtained in presence of a catalyst, preferably MnO_2. In order to practically obtain such a reaction the sodium percarbonate powder is poured into a vessel with water and subsequently the MnO_2 powder is poured starting the reaction. As this reaction is strongly exothermic, it releases oxygen at high temperature and changes part of the water into steam, providing a mixture of oxygen/steam which cannot be directly used for human respiration due to its high temperature and its excessive humidity content. Furthermore the high reaction rate is such that the pressure inside the vessel quickly reaches high values and makes it compulsory, for safety reasons, to build the vessel with suitable materials which, beside affecting the production costs, make the whole set heavy in contrast

with the requirements of an easy handling.

To reduce the decomposition reaction rate of sodium percarbonate it has been proposed to use large quantities of water and to add very slowly the catalyst MnO_2 to this and to the sodium percarbonate. This by the way is not obtainable with portable apparatus and even less in the particularly conditions, generally in emergency, in which these apparatus are utilized, conditions which obviously do not allow the dosage of the catalyst and/or the sodium percarbonate with the correct timing and precision.

Always with the aim of reducing the decomposition reaction rate of sodium percarbonate, it has also been proposed to differ the dissolution of the catalyst MnO_2 into the water, and this can be done using solids composed of MnO_2 powder treated with a solution of polyvinyl alcohol with differentiated concentration. The obtained solids, generally "balls" shaped, are mixed at the moment of use with the sodium percarbonate powder. The addition of water causes a reaction which, thanks to the different solubility of the polyvinyl cover, gradually liberates the MnO_2 thus allowing a control of the reaction. With this measure with 300 g of sodium percarbonate and 600 g of water a production of 1-1,5 litres of oxygen is

obtainable for 20-30 minutes for a total of about 32 litres.

However this solution has not proved satysfactory for the unavoidable formation, jointly with the oxygen production, of steam in such a quantity which does not allow the direct administration to patients, taking into account amongst others the high temperature of the mixture oxygen/steam; it also has a certain cost due to the necessity of using MnO_2 previously treated with polyvinyl alcohol.

An aim of the invention is to avoid such drawbacks and to produce, in a simple and economical form, oxygen by a portable apparatus of extreme semplicity of use, immediatly usable in whichever conditions, also in emergency.

An other aim of the invention is to realize a portable apparatus which allows to produce oxygen directly usable for human respiration.

These aims and others which will result from the following description are obtained, according to the invention, with a process for the production of oxygen by a portable apparatus, particularly for human respiration, characterized in that a mixture of sodium percarbonate and sodium perborate, in presence of a suitable catalyst and water, is made react within a tight vessel according to the

reaction

$$2Na_2CO_3 . 3H_2O_2 + NaBO_2 . H_2O_2 \longrightarrow 2Na_2CO_3 + NaBO_2 + 4H_2O + 2O_2$$

and then the obtained gaseous oxygen and satured steam flow is made pass through an heat exchanger which cools and dehumidifies it.

Advantageously a mixture of sodium percarbonate and sodium perborate can be used in a weight ratio of 1:1 - 1:2, preferably of 1:1,15.

Also advantageously a MnO_2 catalyst or other metal salts such a Fe, Cu, Pb, etc. can be used.

In order to carry out the process, the invention foresees the use of an apparatus comprising a reactor connected to an heat exchanger from which the supply tube containing oxygen and steam departs in such conditions as to allow the direct utilization for human respiration.

Advantageously the heat exchanger can be provided with a coil submerged into a refrigerant liquid and connected to the reactor.

Advantageously the reactor and the heat exchanger can be built separately but mounted on a unique base and can be tight closed by a unique lid.

The present invention is hereinafter further clarified with reference to the enclosed drawings in which:

Figure 1 schematically illustrates the principle on which the process according to the invention is based,

Figure 2 shows in vertical-longitudinal section a portable apparatus according to the invention.

As it can be seen from the drawings the principle on which the present invention is based is to allow, within a portable apparatus, a decomposition reaction of a mixture of sodium percarbonate ($Na_2CO_3.1,5\ H_2O_2$) and of sodium perborate ($NaBO_2.\ H_2O_2$) in presence of a suitable catalyst and water according to the reaction

$$2Na_2CO_3.3H_2O_2 + NaBO_2.H_2O_2 \longrightarrow 2Na_2CO_3 + NaBO_2 + 4H_2O + 2O_2$$

The water has the function of dissolving the components of the mixture and at the same time partially absorbing the heat which develops from the strongly exothermic chemical reaction.

The weight ratio between the sodium percarbonate and sodium perborate is between 1:1 and 1:2, preferably 1:1.15.

The catalyst is preferably of the MnO_2 , but in its place metal salts such as Fe, Cu, Pb, etc. could be advantageously used.

The sodium perborate which, as the sodium percarbonate, participates in the decomposition reaction has

the essential function of reducing the decomposition reaction of the sodium percarbonate, reaction that otherwise would be too strong and would take place in a too short time with respect to the period of oxygen utilization.

The oxygen and steam flow which originate from the reaction are thence made pass through an heat exchanger 2 in which the cooling of the oxygen and the partial condensation of the steam take place, in order that the flow coming out from the heat exchanger 2 has pressure, temperature and humidity characteristics suitable for the direct human respiration.

In order to carry out the process the invention foresees the use of a portable apparatus consisting of three containers, one being the reactor 1 from one side, one being the shell of the heat exchanger 2 on the other side and the third, interposed between the first two, being an overflow interspace 3. The three containers 1, 2 and 3 even if they are physically separed between themselves are mounted on a unique base 15 and can be closed by one single lid 6. The lid 6 is provided with a gasket 7 which completely seals the external perimeter of the three containers 1, 2, 3 beside sealing the internal wall between the heat exchanger 2 and the overflow interspace 3. In parallel to the walls of the

overflow interspace 3, in the lid 6 a baffle 8 is provided extending itself inside the interspace 3 and forming, jointly with the adjacent side wall of the reactor 1, a labyrinth 5.

In the lower zone of the heat exchanger 2 a coil 10 is housed with an end section 11 extending upward to be connected with the overflow interspace 3 near the lid 6.

The other end section 12 of the coil 10 extends along the bottom of the container 2 and it is provided at its end with a suitable diffusor 13. At the section of the lid 6 which closes the container 2 an outlet conduct 14 is applied provided with a standard oxygen tube input connection 4.

In order to carry out the process according to the invention, water is poured into reactor 1 and heat exchanger 2. In the very moment of utilization firstly the catalyst and subsequently the sodium percarbonate and sodium perborate are poured into the reactor 1 and then the apparatus is closed with the lid 6. The mixture decomposition gives start to the oxygen and steam generation which pass from reactor 1 through the labyrinth 5 into the overflow interspace 3 and from here, through the conduct 11, to the coil 10.

Thence through the diffusor 13 they bubble in the shell of the heat exchanger 2. In the coil 10 the oxygen and steam are cooled down and dehumidified and made available, through the conduct 14 and the connector 4, to a cannula or to a mask (not shown in the drawings) in suitable conditions for human respiration.

The mixture of the above mentioned chemical compound gives way to an exothermic reaction which increases the volume of said mixture from two to three times.

In the event that the liquid obtained from the reaction goes over the capacity of the reactor 1 for self-effect or due to improper shaking, oscillation, inclination of the reactor during the reaction, the overflow interspace 3 collects the exceeding liquid without allowing the same to overflow along the conduct 11 in the coil 10.

During the reaction the maximum pressure value inside the reactor 1 is of 0.12 atm. Possible higher pressure, caused by the improper utilization of water at temperature higher than that allowed, which can give way to violent reactions or caused by the involuntary occlusion of the connector 4, are self-regulated by lid 6 which is of a pre-programmed bending type.

In fact the longitudinal structure 9 and the

material used for the construction of the lid 6 allow this to bend in a pre-programmed way. The thickness and the elasticity of the gasket 7 complete such an effect.

So it has been obtained that the lid 6 is water-tight up to the internal pressure of 0.13 atm and that for higher pressure it discharges outside the exceeding oxygen caused by said higher pressure, keeping at constant values both the internal pressure as well has the oxygen supply to the connector 4.

The following example referred to the above described apparatus will further clarify the invention.

In the reactor 1 which has a capacity approximately of 1450 g, 400 cc of water at 20°C have been poured and subsequently 4 g of MnO_2 with the function of catalyst has been poured into it. In the heat exchanger 2, 500 cc of water still at the temperature of 20°C have been poured. The exact quantity of water to be poured into the containers 1 and 2 is easily identified by the two level signs 16 and 17 marked outside of each side container.

A mixture of powder composed by 163 g of sodium percarbonate and by 143 g of sodium perborate has been poured into the reactor 1. Immediately after, the lid 6 has been applied which ermetically closes, through the snap

clamps 18, the container 2 and only perimetrically the containers 1 and 3.

The decomposition reaction of the mixture immediately started which has so originated the substantially uniform generation of oxygen and steam. 32 liters of oxygen at a max. temperature of 68-70°C and a relative humidity of 100% have been totally obtained.

The gaseous flow of oxygen and steam has passed from the reactor 1 to the overflow interspace 3 through the upper connection leak and the labyrinth 5 which has provided to a first crack-down of solid elements in suspension as well as to a partial condensation of the steam. The eventual solid elements and the condensation have been collected in the lower zone of the overflow interspace 3. The gaseous flow has thus passed, through the conduct 11 into the coil 10. Here it has cooled down reaching, through the extreme-end 12, the diffusor 13 which has made it bubble into the refrigerant liquid. This operation has allowed the definitive washing of the gaseous flow eliminating even the smallest solid parts possibly present and still in suspension and the reduction of oxygen alkalinity up to acceptable values for human respiration. At the end the gaseous flow, through the conduct 14 and the connector 4

comes out at an average temperature of 22°C and at a relative humidity of 72%, that is in a suitable condition for the human respiration.

This sperimental test has been carried out pouring as stated above, in the reactor 1 and in the heat exchanger 2 water at the same temperature (20°C) and obtaining at the outlet an oxygen flow of 1,6 litres per minute at a relative humidity of 72%. However these characteristics of the produced oxygen flow can be varied, according to the user's needs, with the simple variation of the temperature of the water poured into the containers 1 and 2. As in fact it results from the following table, when diminishing the water temperature poured into the reactor 1, the oxygen flow diminishes and consequently the duration of the reaction in the reactor 1 increases. Beside the lowering of the water temperature inside the heat exchanger 2 also the relative humidity of the produced oxygen flow diminishes. If, for instance, instead of pouring into containers 1 and 2 water at 20°C, water is poured at 30°C, for a duration of 15 minutes an average oxygen flow of 2.8 litres/minute with a relative humidity of 78% is obtained. If the needs of the user make compulsory both a precise value of oxygen flow as well as its relevant humidity, it will be sufficient to pour

AVERAGE SUPPLY TABLE IN LITERS/MINUTE - WATER TEMPERATURE

OXYGEN FLOW	WATER TEMPERATURE		OXYGEN HUMIDITY	REACTION PERIOD
lt/m	°C	F	(relative)	m'
4,6	41	105	85%	9'00"
4,4	40	104	84%	9'30"
4,4	39	102	84%	9'30"
4,2	38	100	83%	10'00"
4,2	37	98	83%	10'00"
4,0	36	96	83%	10'30"
3,9	35	95	82%	10'45"
3,6	34	93	81%	11'30"
3,2	33	91	80%	13'00"
3,2	32	89	80%	13'00"
3,0	31	87	79%	14'00"
2,8	30	86	78%	15'00"
2,8	29	84	78%	15'00"
2,8	28	82	78%	15'00"
2,8	27	80	78%	15'00"
2,6	26	78	77%	16'00"
2,6	25	77	77%	16'00"
2,4	24	75	75%	17'00"
2,4	23	73	75%	17'00"
2,3	22	71	73%	18'00"
2,3	21	69	73%	18'00"
2,1	20	68	71%	20'00"
2,1	19	66	71%	20'00"
1,9	18	64	70%	22'00"
1,7	17	62	69%	24'00"
1,6	16	60	68%	26'00"
1,5	15	59	67%	28'00"

into the reactor 1 water at the corresponding temperature to the requested oxygen flow (shown in the relevant table) and, in the heat exchanger 2, water at the corresponding temperature to the requested relative humidity (shown in the relevant table).

CLAIMS

1. A process for the production of oxygen by a portable apparatus, particularly for human respiration, characterized in that water with a mixture of sodium percarbonate and sodium perborate in presence of a suitable catalyst is made react within a tight vessel according to the reaction

$$2Na_2CO_3 \cdot 3H_2O_2 + NaBO_2 \cdot H_2O_2 \longrightarrow 2Na_2CO_3 + NaBO_2 + 4H_2O + 2O_2$$

and then the obtained gaseous oxygen and satured steam flow is made pass through an heat exchanger (2) which cools and dehumidifies it.

2. Process according to claim 1 characterized in that a mixture of sodium percarbonate and sodium perborate in a weight ratio of 1:1 - 1:2, preferably at 1:1.15 is used.

3. Process according to claim 1 characterized in that MnO_2 is used as catalyst.

4. Process according to claim 1 characterized in that metal salts such as Fe, Cu, Pb, etc. are used as catalysts.

5. An apparatus to carry out the process according to claims 1 to 4 characterized in that it comprises a reactor (1) connected to an heat exchanger (2) from which the supply conduct (14) containing oxygen and steam departs in such conditions to allow the direct utilization for human

respiration.

6. Apparatus according to claim 5 characterized in that the heat exchanger (2) is provided with a coil (10) submerged in a refrigerant liquid and connected to the reaction (1).

7. Apparatus according to claim 4 characterized in that between the reactor (1) and the heat exchanger (2) an overflow interspace (3) is interplaced.

8. Apparatus according to claim 7 characterized in that the reactor (1), the heat exchanger (2) and the overflow interspace (3) are built separately but are mounted on a unique base (15) and are tight closed by a unique lid (6).

9. Apparatus according to claim 7 characterized in that the coil (10) is provided, at the end not connected to the overflow interspace (3), with a diffusor (13) submerged in the refrigerant liquid.

10. Apparatus according to claim 5 characterized in that the oxygen and steam flow is made pass through the labyrinth (5) consisting in a transversal baffle (8) integral with the lid (6) and extending in parallel to the dividing wall between the reactor (1) and the overflow interspace (3).

11. Apparatus according to claim 7 characterized in that the lid (6) is of the preprogrammed flexibility type.

12. Apparatus according to claims 8 and 11 characterized in that the lid (6) is provided with a gasket (7) of sufficient thickness and elasticity such as to allow the perfect seal up to a prefixed pressure.

13. Apparatus according to claim 5 characterized in that to the supply conduct (14) a connector (4) for an oxygen standard tube input is applied.

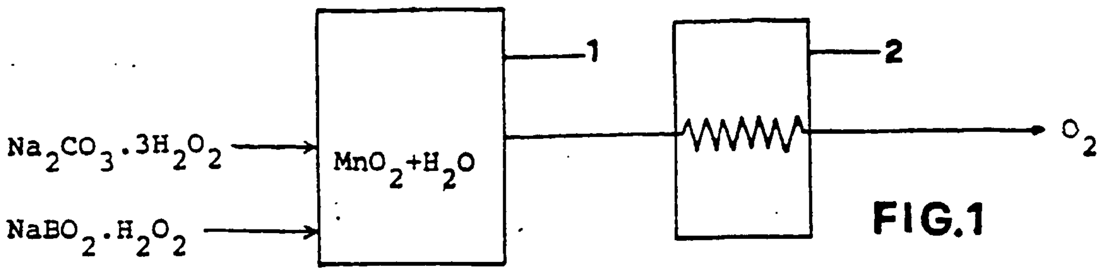
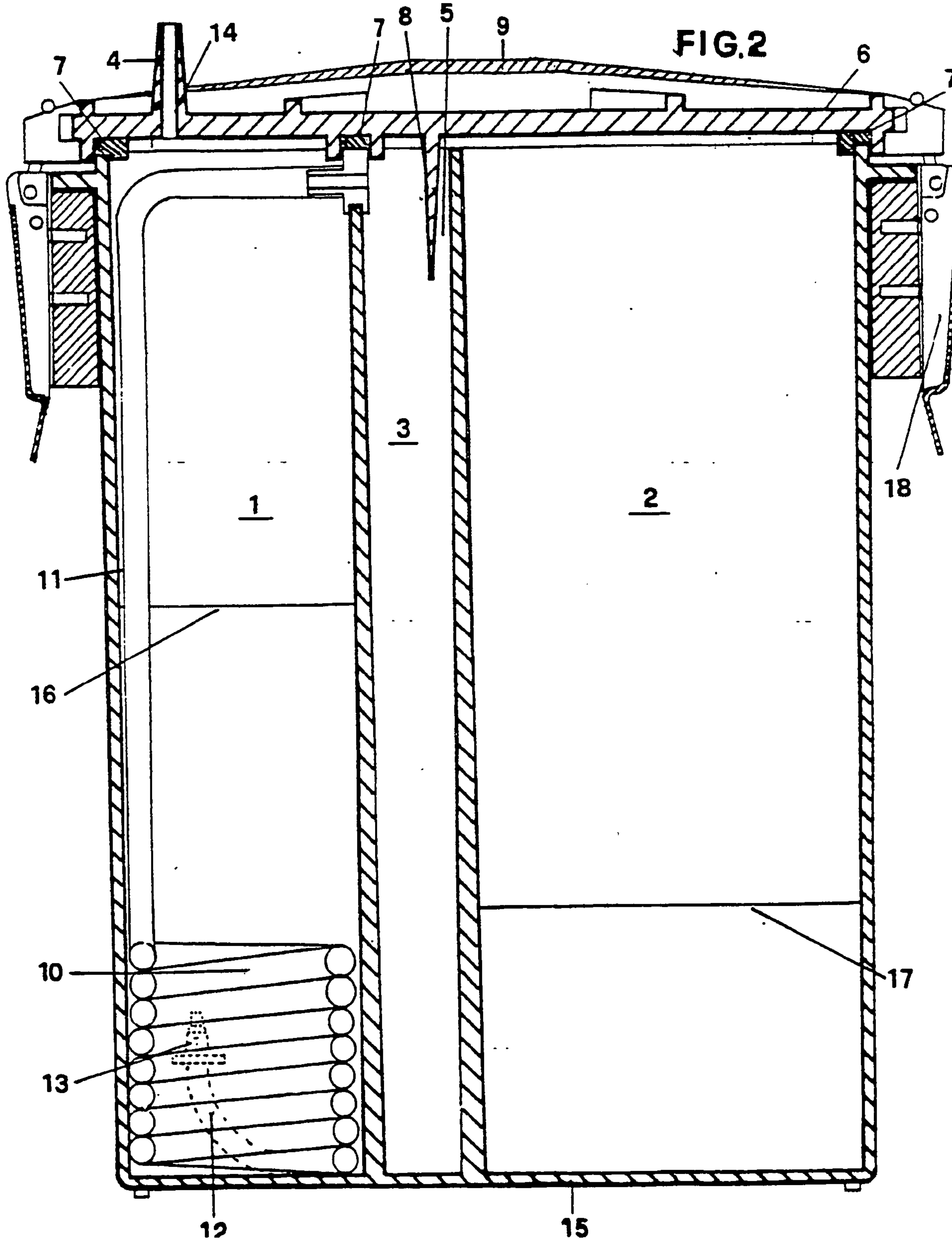

Na2CO3.3H2O2
NaBO2.H2O2
MnO2+H2O
1
2
O2

FIG.1


4
14
7
8
5
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6
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3
1
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11
16
18
10
13
17
12
15

FIG.2

INTERNATIONAL SEARCH REPORT

International Application No PCT/EP 85/00474

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC^4: C 01 B 13/02; A 62 B 21/00

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC^4	C 01 B; A 62 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	EP, A1, 0093938 (HOSHIKO MEDICAL LABORATORIES) 16 November 1983	
A	FR, A, 369468 (BAYOD Y MARTINEZ) 12 January 1907	
A	US, A, 3421842 (DARBEE et al.) 14 January 1969	
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X	Chemical Abstracts, volume 91, no. 8, 20 August 1979, Columbus, Ohio (US) see page 300, abstract 61942j & JP, A, 7792717 (FURUKAWA ALUMINUM; NIPPON PEROXIDE) 2 August 1977	1,4

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* Special categories of cited documents: [10]

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"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
21st November 1985	12 DEC. 1985
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	G.L.M. Kruydenberg

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/EP 85/00474 (SA 10629)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 03/12/85

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A- 0093938	16/11/83	JP-A- 58190804	07/11/83
		US-A- 4508700	02/04/85
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		FR-A- 1494651	
GB-A- 10066		None	

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